Summary of Questionnaire Responses by State Dam Safety Agencies[1]

1. **Discuss your State/agency's extreme precipitation needs for decision making, assessments, and designs (extreme precipitation is defined as those events with a return period of 1,000-years or greater, up to and including PMP):**

   a. **What agencies in your State use extreme precipitation data?**

   The dam safety agencies at the state-level (e.g., Division of Dam Safety, Dam Safety Section, Safety of Dams Program) use extreme precipitation data.

   b. **What extreme precipitation data do you use in your decisions?**

   - PMP, 1/3 PMP, 1/2 PMP
   - Precipitation associated with the 100 and/or 1,000-year return period
   - State-specific and site-specific information
   - Hydrometeorological Reports
   - NOAA Atlas 14

   c. **How is this extreme precipitation data used?**

   - As design criteria for dams or spillways
   - Compute the PMF from the PMP; or %PMF from a %PMP
   - Dam breach inundation studies

   d. **What is the scale and resolution of this data?**

   - Watershed-specific
   - Site-specific
   - Regional

   e. **What is the spatial extent to which this data is applied?**

   The spatial extent is determined by the drainage area upstream of a dam, which is commonly less than 10 square miles. The majority of the drainage areas are less than 100 square miles, while few are several hundred square miles in size.

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1 To capture the view of the States' responses as accurately as possible, the following qualitative indicators were used:
- 'Most' indicates a majority ;
- 'Some' indicates approximately half; and
- 'Few' indicates a minority of responses.

f. Would it be beneficial if this data were updated? And why is that?

The States agree that it would be beneficial to update the data. A multitude of reasons were provided in favor of updating the data:

- The data is old, and it is unknown if the data is conservative.
- The current data is uncomfortably conservative.
- Recent hurricanes and extreme storm events are not included.
- Other frequencies have been updated in NOAA Atlas 14.
- There is a need for rainfall depth and distribution data for sub-10 square mile watersheds and short duration storms.
- There is a need to understand the influence of climate change on extreme precipitation.
- An update to the HMRs would preclude more complex and subjective state- and site-specific PMP studies from being performed.

g. What are the current statutes, regulations, and court rulings regarding extreme precipitation data and methods that apply to your State/agency?

The States do not have statutes or court rulings to dictate requirements for extreme precipitation data and methods. Most States, however, have regulations or guidelines for dam safety that require the PMF or a percentage thereof, depending on drainage area size and hazard classification, to be used for spillway design.

h. Would current statutes, regulations and court rulings allow use of extreme storm products other than NOAA HMR PMP?

Most States prefer the best available data, however, few States have guidelines that dictate that NOAA products must be used.

i. If changes to law or regulations would be needed to allow new use of extreme storm products, describe the revision process.

Each State has their own process for revision of regulations. Some require legislature. Few States would prefer for storm products be endorsed by NOAA.

j. Would your State/agency benefit from updated Federal guidelines regarding the application of new extreme storm products (e.g. revised FEMA National Dam Safety Program guidelines for Spillway Sizing for dams)?

Most States agree that it would be beneficial if Federal guidelines were published regarding the application of new extreme storm products. Few States feel that Federal guidelines would assist in selling new products to dam owners and

politicians. Few States mention that Federal guidelines would benefit dam owners who are regulated by dual government agencies to prevent conflicting instructions. Few States mention that updating current guidelines takes significant effort.

2. **Comment on methods allowed or used by your State/agency to determine extreme precipitation for decision making, assessments, and designs. Please comment on the applicability of each method and on regulations governing each method:**

   a. **HMRs for PMP?**
   Most States require the use of the HMRs to determine PMP, and the resulting PMF from the PMP.

   b. **Frequency precipitation?**
   Some States do not use any precipitation frequency information. Other States utilize the 100-, 500-, and/or 1,000-year precipitation events.

   c. **Site Specific PMP studies?**
   The States are interested in site-specific PMP studies and would consider a study if it were conducted within their region.

   d. **Probabilistic Flood Hazards Approach / Risk-informed decision making?**
   Most States have not used detailed risk analysis for decision making. Few States have used risk analysis to prioritize dams for rehabilitation or to mitigate a deficiency to ensure dam safety. Few States are not allowed to use risk analysis because it is not included in their guidelines.

   e. **Streamflow frequency analysis?**
   Some States do not use or allow streamflow frequency analysis. Other States have accepted streamflow frequency analyses where appropriate data existed.

   f. **Paleo-hydrology studies?**
   Paleo-hydrology studies have not been conducted by States. However, some States would consider such a study. Few States would not consider a paleo-hydrology study because it is not included in their guidelines.

g. **If possible, comment on the relevancy of FEMA Publication 919 "Summary of Existing Guidelines for Hydrology Safety of Dams" with respect to summarizing your State/agency's extreme precipitation methods and needs.**
FEMA Publication 919 appears to be relevant to some States, but this publication does not seem to affect the State's needs and methods.

3. **Describe your State/agency's views and priorities regarding alternatives to traditional PMP:**
   a. **Continued use of PMP, or alternatives?**
   The States continue to use PMP, either as the full PMP or some percentage of PMP, for spillway design. Few States are considering the use of frequency precipitation (e.g. 1,000- or 2,000-year event) but have not fully implemented this practice.

   b. **Have you attempted to use numerical models? Please provide any documentation of the analysis.**
   The States have not attempted to use numerical models.

   c. **Assessment of radar accuracy?**
   Few States have incorporated radar into site-specific PMP studies. None of the States have assessed radar accuracy.

   d. **Estimating probabilities of extreme rainfall?**
   States currently do not estimate the probability of extreme rainfall. Some States, however, believe that it would be beneficial. Few States don't feel that it is possible to estimate the probability of extreme precipitation accurately.

   e. **Storm-based analyses?**
   Few States use storm-based analyses for watershed calibration on rare occasions.

   f. **Historical database of information on storms and floods?**
   The States have varied opinions regarding a historical database. Some use historical information for reference but do not think that it is helpful for day-to-day operations. Few States consider a historical database to be high priority, while few States do not consult a historical database on storms and floods.

4. **Considering the previously mentioned information from FEMA, if a probability or risk-based extreme storm product is developed:**
    a. **Would your State/agency be receptive to implementing the new product?**
    Most States would consider implementing the new product if the product was well-prepared and documented and if it was simple to apply. Few States would not implement a new product.

    b. **Would your State/agency still need updated PMP?**
    Most States would still need an updated PMP.

    c. **How important would it be that risk-based products could be readily used by your existing staff without requiring additional expertise?**
    Some States prefer a product that worked well with definitive procedures to calculate risk more accurately. Some States, however, view a product that was readily useable as critical. Few States cite that the large number of dams and the availability and accuracy of information is the bigger restraint. Few States point out the need for consultants, as opposed to staff, to be able to use the product.

    d. **How important would it be that such products be accompanied by new Federal guidelines for application (e.g. Risk-based guidelines for spillway sizing)?**
    Most States believe that a Federal standard would carry more weight and thus be more likely to get accepted. Few States point out that dam owners who are regulated by dual government agencies would benefit from Federal guidelines. Few States do not believe that a Federal standard is important.

5. **Describe the importance your State/agency places on having a consistent national standard for extreme storm products and having Federal guidelines for such products:**
    a. **In regard to methods and data, is there a need for a national standard?**
    Some States would find it helpful to have consistent standards for larger, high hazard dams. Few States prefer flexibility to select the best methodologies for their needs and would prefer guidelines, not standards.

    b. **In regard to interpretation of risk, is there a need for national standards and Federal acceptance?**
    Most States think a national standard would be beneficial; however, few States are concerned that the thoughts of the individual engineer and state programs could get left behind.

c. **In regards to site-specific PMP studies, is there a need for national standards and Federal guidelines?**
Most States think that national standards would be helpful. Few States indicate that an update to the HMRs would negate the need for more complex and subjective site-specific PMP studies.

d. **In regards to consistent instructions on how to use and apply extreme storm products?**
Most States think that a national standard would be beneficial, especially if the standard could help easily check the validity of the submissions for spillway design.

e. **In regards to the need for extreme storm products to have a consistent level of risk across spatial domains (both between states and within states)?**
Most States think this would be beneficial.

6. **Discuss applicability of current Federal extreme precipitation publications, databases and tools:**
   a. **Hydrometeorological Reports**
      i. **Which HMR do you use most frequently?**
      Most States use HMRs 51 and 52 most frequently.

      ii. **What information do you glean from the HMRs? And how do you use this information exactly?**
      Most States use rainfall depths and temporal distributions provided in the HMRs. Few States use snowmelt parameters and temperature time-series information from HMR 58. This information is used in HEC-1 or HEC-HMS models for spillway design and breach inundation mapping. The snow parameters are used to calculate snowmelt runoff.

      iii. **Which information is most useful?**
      Most States indicate the rainfall depths as the most important information. Few States think that all of the information in the HMRs is useful.

      iv. **Do you use the spatial and temporal storm patterns provided?**

Most States use the spatial patterns for watersheds larger than 10 square miles. Few States do not use this information.

v. **Do you use the DAD tables?**
The answer to this question was split amongst the States: some States use the DAD tables, and some do not.

vi. **Do you use the HMRs to compute PMP?**
Most States use the HMRs to compute PMP.

vii. **Do you use the HMRs to compute a percentage of PMP? Which percentage and what is the basis for reducing PMP?**
Most States only use percentages of the PMF after it is determined by 100% of the PMP.

viii. **Do you use the areal reduction factors provided in the HMRs?**
Most States use the areal reduction factors.

ix. **Do you consider storm seasonality in your studies?**
Most States do not use storm seasonality.

x. **Are the HMRs easy to use? If not, why?**
Most States believe that the HMRs are fairly easy to use. Few States would like to see an easy GIS software program that would compute rainfall distributions and amounts. Few States indicate that the HMRs are unclear for short duration or small area sizes (less than 10 square miles).

xi. **What would you change about the HMRs when/if updated?**
- Easy GIS program
- Address sub-10 square mile watersheds
- Address short duration storms
- Web-based application that could delineate watershed and calculate PMP (similar to USGS StreamStats or NOAA Atlas 14)
- Web-based application to download results in GIS layer or tabular format
- Demonstration of how rainfall and temporal distributions were derived

xii. **What additional information would you want to see included?**

- Sub-10 square mile watersheds
- Instruction for computation of temporal distribution
- Better documentation of the supporting data and any subjective judgment that went into the analysis

xiii. Do you associate a probability to PMP? If so, describe your methodology.
Most States do not associate a probability to PMP. Few States extend frequency plots (using a Pearson Type III probability distribution) for an estimate of the corresponding return period.

xiv. Is updating the HMRs a priority to your State/agency?
The answer to this question is split amongst the States: some States think that an update to the HMRs is a priority, while some do not.

xv. Would your State/agency be interested in contributing to a Federal effort to update PMP? (Data, technical, financial, review, etc.)
Most States would consider contributing to a Federal effort to update PMP.

b. Precipitation-frequency products:

i. NOAA Atlas 14 is being updated to include the Northeastern States (from TP40). Funding has not yet been found to update estimates for Texas (from TP40) or the Northwestern states (From NA2). How important is it to your State/agency to have NOAA Atlas 14 volumes for Texas and the Northwestern states?
Most States do not believe an update for Texas or for the Northwestern states is important.

ii. Do you consult NOAA Atlases 2 and 14? For what reason, exactly?
Most States consult NOAA Atlas 14.

- 24-hour, 100-year values
- 6-hour, 100-year values
- Rainfall distributions
- Consulted for design considerations,
- To assess the potential for erosion near the dam and receiving channel
- To check the reasonableness of PMP estimates and/or site-specific PMP estimates.

iii. **Which return period(s) is most useful for your studies?**

- 2-year
- 5-year
- 25-year
- 100-year
- 1,000-year

iv. **Do you extrapolate beyond the 1,000-year return period (not recommended by NWS)? If so, how?**

Most States do not extrapolate beyond the 1,000-year return period. Few States will apply a Pearson Type III distribution to maximum precipitation data.

v. **Do you currently compute areal estimates based on the point values from NOAA Atlas 2 or 14? If so, how? And where/how do you obtain your areal reduction factors if you use that method?**

Most States do not need areal reduction factors because the watersheds are small. If an areal reduction is needed, the HMRs are consulted.

vi. **Does your State feel there is a need to update areal reduction factors for frequency storms?**

Some States did not have an answer to this question. Few States thought this could be a need.

vii. **To what extent is NOAA Atlas 14 information incorporated into design guidance or regulations that govern what you do?**

Some States use NOAA Atlas 14 information, but NOAA Atlas 14 is not incorporated into States' guidance or regulations. The information that is referenced include: 5-year, 25-year, 100-year storms at the 24-hour duration and the 1,000-year event.

viii. **Are there elements in NOAA Atlas 2 or TP 40 missing in NOAA Atlas 14?**

The States were not aware of any missing elements.

ix. **Is NOAA Atlas 14 easy to use? How could it be improved?**

Most States find NOAA Atlas 14 to be easy to use. Few States found it difficult to import the rainfall distributions into hydrology models. Few

States were interested in the precipitation stations that were used in the regional precipitation-frequency calculations.

x. **Do you input latitude/longitude values into the web interface?**
Most States enter in latitude/longitude. Few States navigate by the map interface.

xi. **Do you consult the isopluvial maps of precipitation frequency estimates for a particular exceedance probability and duration? If so, what value do they provide beyond the GIS compatible grids of the same information?**
The States do not use this feature.

xii. **Of what value are the temporal distribution curves in NOAA Atlas 14?**
Most States find the temporal distribution curves to be of little value.

xiii. **Of what value are the seasonal curves in NOAA Atlas 14?**
The States find the seasonal curves to be of little value.

xiv. **There is a difference between precipitation frequency estimates more frequent than about 15-20 years ARI for estimates derived from annual maximum series and estimates derived from partial duration series. How important is it for NOAA Atlas 14 to provide both? Which of the two is your preference and why?**
The States do not have an opinion on this issue at this time; however, it was indicated by few States that both need not be provided but rather an explanation be included for the one that was provided.

xv. **Do you consult the report documentation of NOAA Atlas 14 for any purpose?**
Most States do not consult the report documentation. Few States refer to the documentation to understand the methodology that was implemented.

xvi. **Do you use any of the background information that the NWS used to compute the precipitation frequency estimates? If so, what exactly? (e.g., gauge data, clusters)**
The States do not use the background information.

7. **What other extreme precipitation resources does your State/agency utilize?**
    a. **Non-Federal technical documents on extreme storms or PMP?**
    None.

    b. **Other non-Federal documents?**
    None.

    c. **Data?**
    None.

    d. **Software?**
    Few States use software provided by NRCC.

8. **Describe ongoing and planned efforts in your State to update PMP or develop new extreme storm products?**
    - Possible revision of use of percentages of the PMP to using 1,000-year and 2,000-year floods generated by statistical analyses
    - Case by case studies of site-specific PMP
    - State-wide PMP study
    - Revision of the Dam Hazard Classification evaluation procedure to include more risk-informed decision-making or criteria
    - Potential modification to the selection of design frequency storms for each dam hazard classification
    - Revision of regression equations for determining basin unit hydrograph parameters

9. **Discuss any gaps or further needs:**
    a. **What precipitation/extreme storm information do you need that you don't have now?**
        - Information regarding developing and using frequency based extreme precipitation
        - Updates of existing storm information
        - HMR 52 software in GIS format
    b. **For data gaps, what is the most pressing piece of information that needs to be created or updated?**
        - Information regarding developing and using frequency based extreme precipitation

APPENDIX D

- New rainfall estimates in HMR 51
- Methods for applying rainfall to a watershed